J. HYM. RES.
Vol. 13(2), 2004, pp. 250–261

Hooked Hairs and Not So Narrow Tubes: Two New Species of *Colletes* Latreille from Texas (Hymenoptera: Apoidea: Colletidae)

JOHN L. NEFF

Central Texas Melittological Institute, 7307 Running Rope, Austin, Texas 78731;
email: jlnatctmi@yahoo.com

Abstract.—Two new species, ***Colletes bumeliae*** **Neff** and ***Colletes inuncantipedis*** **Neff**, are described from central Texas, U.S.A. Both have arrays of specialized, recurved setae on their foretarsi which are used to extract pollen from flowers of *Sideroxylon lanuginosum* (A. Michaux) Pennington (Sapotaceae), their primary floral host. Nests and provisioning behavior are described for *C. inuncantipedis.*

Colletes is a nearly cosmopolitan genus of bees consisting of more than 440 species (Michener 2000, Kuhlmann 2003). Roughly 100 species have been recorded from North and Central America, making *Colletes* one of the larger genera of American bees (Michener et al. 1994). While many species of *Colletes* are believed to be oligolectic (Stephen 1954, Moldenke 1979, Mader 1999, Müller and Kuhlmann 2003) very little has been reported on either their pollen collecting behavior or any morphological features which may enhance pollen harvesting by these bees. This is not particularly surprising since most North American *Colletes* lack obvious specializations for pollen harvesting beyond the usual branched body hairs and tarsal and tibial brushes of simple setae (Thorp 1979). The few exceptions include the sternal setal brushes of females of some members of the *consors* group of Stephen (1954) used for pollen collection during vibratile pollen harvesting from the flowers of *Chamaesaracha*, *Quincula* and *Physalis* (all Solanaceae) (Stephen 1954, J. L. Neff pers. obs.), and arrays of hooked setae on the clypeus and frons of an undescribed Mexican species that aid in collecting pollen from the nototribic anthers of flowers of the Lamiaceae (G. Dieringer, pers. com.). In addition, females of some Mesoamerican *Colletes* (including *C. isthmicus* Swenk and *C. mexicanus* Cresson) have a metasomal scopa comprised of setae with hooked apices (Griswold et al. 1995). I here add to this short list by describing two distinctive new species from central Texas. Females of both species have unusual arrays of hooked setae on their foretarsi which are employed in the collection of pollen from the partially hidden anthers of flowers of *Sideroxylon* Linnaeus (Sapotaceae).

MATERIALS AND METHODS

Morphological nomenclature follows Michener (2000) with the addition of the terms clypeal apicomedial and apicolateral fovea for the sensillae bearing fovea on the apical margin of the clypeus. Definitions for abbreviations and measurements are as follows: UIOD—upper interocular distance (minimal distance between compound eyes on upper part of face); LIOD—lower interocular distance (minimal distance between compound eyes on lower portion of face); MIOD—maximal interocular distance (maximal distance between compound eyes); OCD—ocellar diameter; PW—puncture width; T1, T2, T3 . . .—Metasomal Tergum 1, Tergum 2, Tergum 3 . . . ; S1, S2, S3 . . .—Metasomal Sternum 1, Sternum 2, Sternum 3 . . . ; BL—body length (length front of vertex to posterior margin of T2); FW—forewing length (measured from base of the radial cell to apex of marginal cell); HW—head width (maximal width in frontal view). Acronyms used include: BFL—Brackenridge Field Laboratory of The University of Texas, Austin, Texas; SEMC—Natural History Museum, University of Kansas, Lawrence, Kansas; TAMU—Entomology Collection of Texas A & M University, College Station, Texas and J.L.N.—J.L.Neff.

The lengths of the foretarsi (and femora and tibiae) of female *Colletes bumeliae* and *C. inuncantipedis* were compared with those of females lacking the specialized hooked hairs. Lengths were adjusted for size by dividing the appropriate leg length by head width. Adjusted tarsal and other leg length measures did not differ between *C. bumeliae* and *C. inuncantipedis* so they were combined for further analyses. For comparative purposes, I also used two measures of forewing length as the divisor: as defined above and, in unworn specimens, from the base of the radial cell to the distal wing apex). Seventy-five individuals from 39 species (two or rarely one female per species), were used for the analysis (11 females were excluded due to extensive wing wear for the second wing length analysis). *Colletes* species included in the tarsal length analysis are: *C. aestivalis* Patton, *C. algarobiae* Cockerell, *C. aztekus* Cresson, *C. aridus* Stephen, *C. beamerorum* Stephen, *C. birkmanni* Swenk, *C. brevicornis* Robertson, *C. cercidii* Timberlake, *C. clypeonitens* Swenk, *C. compactus* Cresson, *C. delicatus* Metz, *C. deserticola* Timberlake, *C. eulophi* Robertson, *C. fulgidus* Swenk, *C. gilensis* Cockerell, *C. gypsicolens* Cockerell, *C. hyalinus* Provancher, *C. intermixtus* Swenk, *C. louisae* Cockerell, *C. latitarsis* Robertson, *C. mandibularis* Smith, *C. mitchelli* Stephen, *C. nigrifrons* Titus, *C. paniscus* Viereck, *C. perileucus* Cockerell, *C. prosopidis* Cockerell, *C. saritensis* Stephen, *C. scopiventer* Swenk, *C. simulans* Cresson, *C. skinneri* Viereck, *C. sleveni* Cockerell, *C. swenki* Stephen, *C. texanus* Cresson, *C. thoracicus* Smith, *C. willistoni* Robertson, *C. wilmattae* Cockerell and *C. wootoni* Cockerell.

Colletes bumeliae Neff, new species

Diagnosis.—The female of *Colletes bumeliae* is easily distinguished from all other Nearctic *Colletes*, except *C. inuncantipedis*, by the distinctive arrays of hooked hairs on its forebasitarsi. It fails at couplet 71 in the female key of Stephen (1954) due to the absence of dark hairs on the mesoscutum and scutellum; mesepisternum strongly punctate, not rugose; and absence of basal fascia on T2. The male runs to *Colletes kansensis* Stephen (couplet 71 in Stephen's key) but is readily distinguished by the shape of the 7th sternite, the punctation of T1 fine and sparse medially, and the tegulae translucent brown, not black. *Colletes bumeliae* is clearly closely related to *C. inuncantipedis*. The form of the genitalia and the metapleural prominence suggest *kansensis* may be the closest relative to these two species. Unfortunately, the female of *kansensis* is unknown.

Description.—♀. Measurements: (N = 9) BL: 7.0–8.2 mm; FW: 4.5–5.2 mm; HW 2.8–3.1 mm. ***Head***: Face 1.24–1.29 × wider than long, greatest distance between eyes exceeding eye length, inner orbits strongly convergent below and arched inward above (UIOD 1.11–1.15 × LIOD, UIOD 0.81–0.89 × MIOD). Malar space about ¼ as long as wide. Clypeus slightly produced with depressed, flattened, impunctate, apical margin; clypeal disk shining, densely, striately punctate, often with small, shining, impunctate medioapical area; punctures smaller, denser and nonstriate basally and laterally. Clypeal apicomedial fovea large and round, apicolateral fovea smaller and much weaker. Disc of supraclypeal area raised, surface dull and microstriate with sparse, moderate, punctures; punctation of lateral surfaces smaller and much denser. Median line carinate from above supraclypeal area to median ocellus. Disc of labrum rounded, shining, impunctate, without median groove. Frons with punctures strong, dense and nearly contiguous. Facial fovea deeply impressed, broadest medially but restricted above, curving inward towards lateral ocellus; upper margin of fovea at or slightly above line between summits of eyes, upper inner margin of fovea narrowed, within 1 OCD of lateral ocellus, fovea tapering below, extending to level just above upper margin of antennal fossae; surface dull, microstriate. Vertex shining, densely, minutely punctured except shining impunctate area between lateral ocelli and facial fovea. Gena narrow, broadest below; genal width 0.5 × eye width at level of antennal insertion; punctures dense above becoming striate below and on hypostomal area. Scape slender, length 5 × apical width. Minimal length first flagellar segment short, minimal length slightly less than apical breadth. Middle antennal segments slightly longer than broad. ***Thorax***: Pronotal spine short but sharp; broad basally, abruptly narrowing to acute tip. Tegulae sparsely punctate, most punctures in apical ⅓. Mesoscutum shining, disc strongly punctate with punctures separated 1–1.5 pw on anterior ⅔, punctures much sparser on posterior ⅓, punctures finer and denser on anterior and posterior mesoscutal margins. Scutellum shining, punctures strong, similar to discal mesoscutal punctures on posterior ⅔, punctures smaller and denser on posterior margin but very sparse, nearly impunctate on anterior third. Metanotum rugose. Mesepisternum anterior to quadrately pitted episternal groove densely punctate; punctures slightly coarser than those of mesoscutum, punctures less than 1 pw apart. Mesepisternum posterior to groove with punctures decreasing in size and density posteriorly (except punctures dense along meso-metepisternal suture) with posterior most punctures <½ diameter of anterior punctures; interspaces shining; hypoepimeral area shining, sparsely punctate. Metepisternum shining, quadrately pitted; metapleural prominence small, rugose, with short, opaque, curved, carinate rim above small shining declivity. Propodeum with dorsal area shining, quadrately pitted; posterior surface of propodeal triangle shining; posterior propodeal surface outside triangle coarsely roughened, posterolateral margins of propodeum weakly carinate. Fore basitarsis broad, subrectangular (basal width 0.37 × length, fore basitarsal length 0.58 × fore tibia); hind basitarsis broad, roughly 3× as broad as long, sides subparallel. ***Abdomen***: Terga shining, with narrow impunctate margins; punctation of T1 fine and dense laterally but much sparser, nearly impunctate in medial ¼ to ⅕; discal punctation of distal terga uniformly fine and dense. Punctation of S 1–2(3) moderately dense, slightly coarser than terga, becoming finer on distal sterna, apical margins of sterna with narrowly translucent. Apex of S6 slightly depressed, surface shining with density of punctures decreasing towards apex. ***Vestiture***: Pile of face white, dense and partially obscuring surface on frons but sparse on vertex, clypeus and supraclypeal area; hairs of clypeus, short, sparse, simple and semi-appressed; 1–2 long, bent, flattened simple setae in apicomedial fovea of clypeus, 3–4 shorter branched setae in apicolateral fovea. Pile of vertex pale yellowish-white, hairs branched and relatively dense in and behind ocellar triangle but sparse and simple in ocello-ocular space; hair of upper part of gena dense with numerous short branched hairs, appressed along upper posterior margin of eye, becoming much sparser and less branched below. Pile of mesoscutum and scutellum pale, yellowish-white, hairs short with numerous long branches; dense fringe of white, branched hairs on posterior margin of pronotal lobe, pile of mesepisterna, erect and sparse, not obscuring surface; propodeal corbicula well developed with strong dorsoposterior fringe of pale hairs, weakly delimited anteriorly with short fringe of pale branched hairs, corbicular surface with mix of appressed short hairs and erect simple hairs, latter primarily in posterolateral third. Anterior series of parallel branched femoral scopal hairs typical for genus but posterior series of radially branched hairs reduced, consisting of ca. 25. Foretarsi with abundant erect, hooked simple hairs, particularly on dorsal surface of basitarsis and apices of distal tarsal segments. Usual brushes of simple hairs of hind basitarsis also well developed on distal tarsal segments. Hair of coxae, trochanters and femora white or off-white. Hair of tibiae and tarsi white. Pile of T1 white, relatively dense anterolaterally with sparse, erect hairs anteromedially, becoming very sparse on disc, with complete apical white fascia; T2–5 with complete apical white fascia, but fascia weak on T4 and 5. Discs of T2–5 with short dark hair not obscuring surface; with sparse, pale, erect hair on lateral margins. T6 with mix of appressed long and short dark hair. S1 with erect pale branched hairs, S2–6 with sparse simple semi-appressed hairs, hairs shortest on basal portion of each sternite, becoming longer distally but not forming distinct fascia. **Color**: Black, except mandibles, tibial spurs, pretarsal claws; terga 3–6, sterna and distal tarsomeres brown; apices of T 1–4 and S 1–5 narrowly translucent brown. Tegulae translucent brown; wings hyaline, with abundant short dark hairs, veins reddish brown with pterostigma translucent reddish brown.

♂.—Measurements: (N = 10) BL, 5.1–8.2 mm; FW 4.4–5.7 mm, HW 2.5–3.2 mm. ***Head***: Face 1.24–1.44 × wider than long, greatest distance between eyes slightly greater than eye width; inner margins strongly convergent below, UIOD 1.25.1.39 × LIOD, UIOD 0.85–0.92 MIOD. Malar space 0.4 times as long as wide. Clypeus with disc raised and rounded, surface shining, punctures fine, dense and elongate medially, but much sparser laterally, almost impunctate anterolaterally, apical margin narrowly depressed. Labrum with disc evenly rounded, impunctate and shining. Supraclypeal area densely punctate, medial punctures roughly twice diameter of peripheral punctures. Supraclypeal median line carinate to just below median ocellus. Punctures of frons coarse and dense. Facial fovea relatively narrow, expanded subapically, upper portions of facial fovea strongly depressed along edge of eyes, outer margins carinate, surface of fovea dull. Punctures of vertex fine, dense with impunctate space laterad ocelli. Gena shining, finely punctate, distinctly depressed along eye margin medially, narrow above but considerably wider below. Scape short, approximately 2× longer than width, first flagellar segment short, length 0.9 × apical width, middle flagellar segments 1.5–1.6 × as long as wide. ***Thorax***: Prothoracic spines rudimentary, little more than carinate angle. Mesoscutum shining, strongly punctate with punctures separated by 1–2 pw anteriorly and laterally, discal punctures widely separated; punctures of scutellum similar, dense laterally and posteriorly but very sparse, nearly impunctate anteriorly. Metanotum rugose. Mesepisternum, anterior to quadrately punctate mesepisternal groove, densely punctate; punctures slightly coarser than those of scutum, punctures less than 1 pw apart. Punctures of mesepisterna posterior to groove punctures similar to those of mesoscutum, dense anteriorly but sparser posteriorly and ventrally to 2–3 pw apart, interspaces shining. Hypoepimeral area shining with strong well-separated punctures; metepisternum shining, quadrately pitted. Metapleural prominence small, rugose, with short, curved carinate rim above small shining declivity. Propodeum with dorsal area shining, divided into irregular quadrate pits by longitudinal carinae, posterior surface of propodeal triangle shining, posterior propodeal surface outside triangle coarsely roughened, posterolateral margins of propodeum weakly carinate. Fore trochanter simple; fore femur slightly expanded mediodorsally, 3.6 × as long as broad; fore tibia 4.2 × as long as broad; hind tibia not expanded, 5.0 × as long as broad; posterior basitarsi 4.5 times as long as broad, sides parallel. ***Abdomen***: T1 shining: lateral and posterior punctures fine and dense but well separated on disc: sometimes with median impunctate line, apical margin depressed, apex narrowly translucent. T2–6 with surface shining, punctures fine and dense, roughly 1 pw apart, margins narrowly translucent. T7 strongly depressed, surface dull and densely punctate. Sterna weakly shining, with fine reticulate shagreening, fine punctures 1–2 pw apart throughout except on narrow, impunctate translucent margins; genitalia, S7 and S8 as illustrated (Figs. 3a–d); penis valves without dorsal wing; distal processes of S7 short and membranous. ***Vestiture***: Pile of face long, pale yellowish white, concealing facial surface except apex of clypeus exposed. Pile of vertex pale ochraceous, much sparser, fine hairs in ocello-ocular areas with denser, conspicuously branched hairs in and behind ocellar triangle. Pile of gena pale yellowish white near vertex, becoming whiter and longer below and on hypostomal area. Pile of mesoscutum and scutellum pale ochraceous. Pile of sides of thorax sparse, pale yellowish white with dense dorsolateral propodeal fringe pale ochraceous above. Hair of legs yellowish-white. T1 with long pale yellowish-white hair, dense laterally but very sparse medially, not extending to complete, white, apical fascia. T2–5 with complete, white, apical fascia, apical fascia absent on T6; T2–5 with hairs of disc very short, black, with increasing mix of longer, pale hairs posteriorly, lateral portions of T2–5 short, white. T6–7 with sparse, pale, appressed hairs. S1 with hairs white, sparse; S2–6 with pile white, that on discs simple, sparse and semi-appressed; apices S2–5 with distinct apical fascia of appressed, branched hairs, fascia strongest on S2 becoming progressively weaker on distal sterna. ***Color***: Black; antennae black to dark brown; mandibles with apical ⅔ translucent reddish brown; wings as in female; legs dark brown with tarsi ferruginous, tibial spurs pale brown.

Material examined.—Holotype ♀: USA: Texas: Bastrop Co: Sayersville (30° 12.99′ N, 97° 20.99′ W); 11-VI-1991; J. L. Neff; on flowers of *Sideroxylon lanuginosum* (deposited SEMC). Allotype ♂: same data as holotype (deposited SEMC). Paratypes: 18 ♂♂ and 2 ♀♀, same data as holotype: 1 ♂ and 1 ♀, same data except 9-VI-1986; 1 ♀, same data except 10-VI-1990 and taken in nest; 9 mm, same data except 3-VI-1992 and at flowers of *Sideroxylon lanuginosum*; 3 ♂♂, same data except 6-VI-1994; 2 ♂♂, same data except 17-VI-1994; 2 ♀♀, same data except 30-VI-1997; 1 ♀, Camp Swift Military Training Area, 12-VI-2003, A. Hook. Blanco Co.: 2 ♀♀, Pedernales Falls State Park (30°19.94′ N, 98°15.37′ W), 25-VI-1988, J. L. Neff, in nest; 2 ♂♂, same data except 2-VII-1988 and at flowers of *Sideroxylon lanuginosum*; 1 male same data except 27-VI-1997.

Etymology.—From the sapotaceous genus *Bumelia* Swartz, a junior synonym of *Sideroxylon* (Pennington 1990), the apparent sole pollen host of the species. I find *bumeliae* to be more mellifluous than names based on *Sideroxylon*. In addition, recent molecular studies suggest the resurrection of *Bumelia* for the American species of *Sideroxylon* may be justified as *Sideroxylon* appears to be paraphyletic (Anderberg and Swenson 2003).

Colletes inuncantipedis Neff, new species

Diagnosis.—The female of *Colletes inuncantipedis* is distinguished from all other American *Colletes* (except *C. bumeliae*) by the distinctive arrays of hooked setae on its foretarsi. Females can be distinguished from *C. bumeliae* by their smaller size, presence of dark hair on the vertex and mesoscutum, and more complete discal punctation of T1. The males of *C. inuncantipedis* are very similar to males of *C. bumeliae* but are slightly smaller and differ in the shape of S7 and the well-formed propodeal spine (rudimentary in *C. bumeliae*).

Description.—♀. **Measurements**: (N = 10) BL: 6.6–7.8 mm; FW: 4.5–4.9 mm; HW 2.8–3.0 mm. ***Head***: Face 1.20–1.29 × wider than long, greatest distance between eyes exceeding eye length, inner orbits convergent below and arched inward above (UIOD 1.11–1.21 LIOD, UIOD 0.80 × 0.86 MIOD). Malar and clypeus as in *C. bumeliae* except clypeal striae irregularly convergent in medioapical impunctate area. Disc of supraclypeal area raised, shining, microstriate with strong, well-separated punctures; punctation of lateral surfaces smaller and much denser. Median line carinate from above supraclypeal area to preocellar triangle. Labrum, frons, vertex and facial fovea as in *C. bumeliae*. Gena as in *C. bumeliae* but slightly wider, width approx. 0.6 × eye width at level of antennal insertion. Flagellum as in *C. bumeliae*. ***Thorax***: Thorax and legs as in *C. bumeliae* except forebasitarsis slightly longer and narrower; basal width 0.33 × length; length 0.60 × length of foretibia. ***Abdomen***: Terga as in *C. bumeliae* except discal punctation stronger, more uniform, without median impunctate area. Punctation of sterna similar to *C. bumeliae* but coarser, particularly on S6 where apical punctures are strong and dense. ***Vestiture***: Pile of face as in *C. bumeliae* except vertex with mixture of yellowish-white and darker brown to black hair. Pile thorax as in *C. bumeliae* except brown to black hair sparsely mixed among pale pile of scutum. Hair of legs *C. bumeliae*. Pile of terga as in *C. bumeliae* except T-5 without pale apical fascia. Pile of sterna darker and denser, particularly on distal ½ of S6. ***Color***: Black, except apical half of mandibles, tibial spurs, and tarsal claws dark reddish brown; apices of T 1–4 and S 1–5 narrowly translucent brown. Tegulae dark brown to black; wings hyaline, with abundant short dark hairs, veins dark brown with pterostigma dark brown.

♂.—**Measurements**: (N = 7), BL: 6.3–7.4 mm; forewing 4.3–5.3 mm, HW 2.6–2.9 mm. ***Head***: Face 1.20–1.24 × wider than long, greatest distance between eyes slightly greater than eye width; inner margins strongly convergent below and weakly incurved above, UIOD distance 1.31–1.41 × LIOD, UIOD 0.91–0.94 × MIOD. Malar space 0.4 times as long as wide. Clypeus densely, finely, punctate, discal punctures slightly sparser apically, apical margin narrowly depressed. Labrum with disc evenly rounded, impunctate and shining. Supraclypeal area densely punctate, medial punctures roughly twice diameter of peripheral punctures. Median line carinate from apex of supraclypeal area to just below median ocellus. Punctures of frons coarse and dense. Facial fovea well defined, narrow, expanded subapically, upper portions of facial fovea strongly depressed along edge of eyes, outer margins carinate, surface of fovea dull. Punctures of vertex fine, dense with impunctate space laterad of ocelli. Gena shining, finely punctate, distinctly depressed along eye margin medially, narrow above but considerably wider below. Scape strongly punctate, short, approximately 2× longer than apical width; first flagellar segment short, length 0.9 × apical width; middle flagellar segments 1.5–1.6 × as long as wide. ***Thorax***: Prothoracic spines short and sharp. Mesoscutum shining, strongly punctate with punctures separated by 1–2 pw anteriorly and laterally, discal punctures 2–3 pw apart; punctures of scutellum similar, dense laterally and posteriorly but very sparse, nearly impunctate anteriorly. Mesepisterum, anterior to quadrately punctate mesepisternal groove, densely punctate, punctures slightly coarser than those of scutum, punctures less than 1 pw apart. Punctures of mesepisterna posterior to groove similar to those of scutum, dense anteriorly but sparser posteriorly and ventrally to

2–3 pw apart, interspaces shining. Hypoepimeral area shining with strong well separated punctures. Metepisternum shining, quadrately pitted; metapleural prominence small, rugose, with short, curved carinate rim above small shining declivity. Propodeum as in *C. bumeliae*. Foretrochanter simple; forefemur slightly expanded mediodorsally, 3.6 × as long as broad; fore tibia 4.2 × as long as broad; hind tibia not expanded, 5.0 × as long as broad; posterior basitarsi 4 × as long as broad, sides parallel. ***Abdomen***: T1 shining, lateral and posterior punctures fine and dense but well separated on disc, apical margin depressed and narrowly translucent. T2–6 with surface shining, punctures fine and dense, roughly 1 pw apart, margins narrowly translucent. T7 strongly depressed, surface dull and densely punctate. Sterna weakly shining, with fine reticulate shagreening, fine punctures 1–2 pw apart throughout except on narrow, impunctate translucent margins; genitalia and S8 as in *C. bumeliae* (Figs. 3a–d), S7 as figured (Fig. 3e) with elongate, strong distal processes (not short and membranous as in *C. bumeliae*). ***Vestiture***: as in *C. bumeliae*. ***Color***: Black; antennae black to dark brown; mandibles with apical ⅔ translucent reddish brown; wings as in female; legs dark brown with tarsi ferruginous, tibial spurs pale brown.

Material examined.—Holotype ♀. USA: Texas: Bastrop Co., Bastrop, 0. 5 mi. N (30° 08.11′ N, 97° 19.24′ W), J.L. Neff, 30-VI-1997. on flowers of *Sideroxylon lanuginosum* (deposited SEMC). ♂: same data as holotype (deposited SEMC). Paratypes: 3 ♀♀ and 19 ♂♂, same data as holotype. 13 ♀♀, same data as holotype except 17-VI-1998. Travis Co.: 1 ♂, Austin, BFL (30° 17.10′ N, 97° 46.83′ W), 6-VI-1986, J. L. Neff, on flowers of *Eysenhardtia texana*; 1 ♂, same data except 12-VI-1987 and on flowers of *Sideroxylon lanuginosum*; 2 ♂♂, same data except 18-VI-1987; 1 ♂, same data except 24-VI-1997.

Etymology.—The name refers to the unusual arrangement of hooked setae on the foretarsi and is a combination of *inuncantis* (Latin—covered with hooks) and *pedis* (Latin—leg).

BIOLOGY

We have occasionally encountered males of *Colletes bumeliae* nectaring at, and patrolling, the flowers of *Eysenhardtia texana* Scheele (Fabaceae) and one male bore pollinia of Asclepiadaceae on its mouthparts, but males of *C. bumeliae* and *C. inuncantipedis* are normally observed only about flowers of *Sideroxylon lanuginosum* (A. Michaux) Pennington (Sapotaceae) (= *Bumelia lanuginosa*) (Fig. 1b). Females of *C. bumeliae* and *C. inuncantipedis* have only been observed at flowers of *S. lanuginosum*, with most females bearing scopal loads or extensive loads of pollen on their foretarsi. All scopal pollen loads examined consisted solely of *Sideroxylon* pollen (n = 20). All evidence points to both species being oligolectic on *Sideroxylon*.

Sideroxylon lanuginosum is a widespread tree or shrub (2–15 m tall) of the Southeast and South Central U.S.A. and adjacent Mexico, commonly known as gum bumelia, gum elastic, chittamwood or woolybucket bumelia (Cheatham et al. 2000). *Sideroxylon lanuginosum* normally flowers in middle to late June in central Texas, producing large numbers of small, pale, short-lived, nectiferous flowers. The tubular, distally spreading corolla is 3–4 mm long. Each flower has five fertile anthers, each of which is subtended by a petaloid staminode. The anthers are not included in the basal floral tube but rather are partially hidden in the distal folds of the corolla (Fig. 1b). I have observed female *C. inuncantipedis* first inserting their heads into the corolla, apparently to lap nectar, and then inserting their forelegs into the corolla, apparently to gather pollen (Fig. 1a). The hooked foretarsal hairs of female *C. bumeliae* and *C. inuncantipedis* often bear much *Sideroxylon* pollen and obviously aid in extracting pollen from the partially hid-

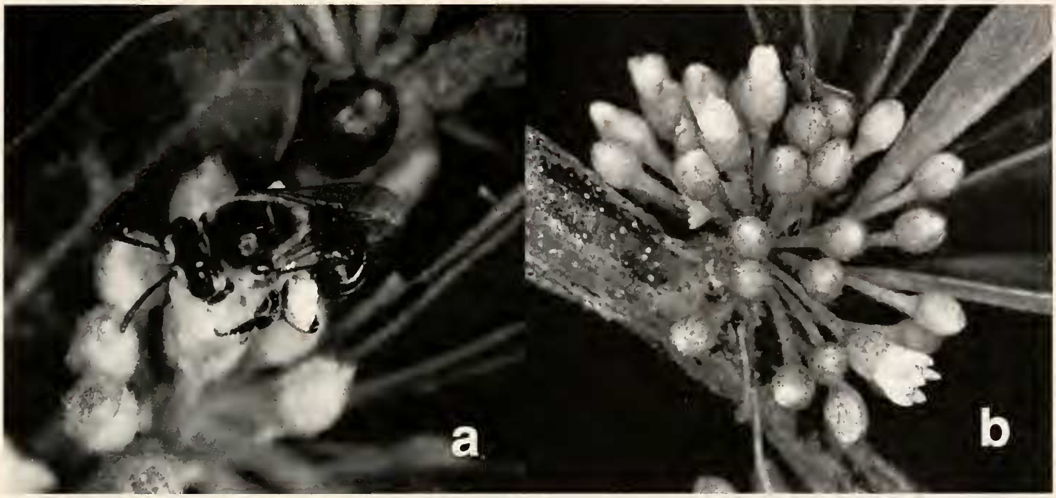

Fig. 1. Flowers of *Sideroxylon lanuginosum*. a. Pollen-collecting female of *Colletes inuncantipedis* inserting forelegs into corolla. b. *Sideroxylon* inflorescence.

den anthers. The exact mechanics of how *C. bumeliae* and *C. inuncantipedis* extract pollen of *S. lanuginosum* has yet to be determined because most pollen collecting visits are relatively rapid (< 5 sec), and occur high in the canopy. The foretarsi, with their arrays of hooked hairs, apparently are pulled over the anthers which are partly hidden by the lateral folds of the corolla and the subtending staminodes. This pollen collecting behavior appears to be analogous to that of various *Calliopsis* (*Verbenapis*) spp. which employ hooked tarsal hairs to extract pollen from anthers hidden in the narrow corollas of various Verbenaceae (Shinn 1967), with the obvious difference that the corollas of *Sideroxylon* are not particularly narrow and the anthers are much more exposed.

While the adjusted combined length of the femur and tibia of the forelegs does not differ between *C. bumeliae* and *C. inuncantipedis* and a sample of North American *Colletes* (0.871 ± .032 (n = 19) vs. 0.881 ± .044 (n = 75), p = .3408, unpaired t-test), the adjusted foretarsal lengths of *C. bumeliae* and *C. inuncantipedis* are significantly shorter than average of the sample of North American *Colletes*, (0.490 ± .011, (n = 18) vs. 0.511 ± .034, n = 75, P < .0001, unpaired t-test).

The foretarsal arrays of hooked setae of females of *Colletes bumeliae* and *C. inuncantipedis* are apparently unique among Nearctic and Neotropical *Colletes* species (Figs. 2a, b). The foretarsi of most New World *Colletes* I have examined only bear simple hairs (Figs. 2e, f), although the females of few species, such as *C. skinneri* or *C. wootoni*, have foretarsal combs with dense arrays of apically hooked hairs (Figs. 2c, d). The function of the hooked hairs for these bees is unclear as neither is closely associated with tubular flowers. *Colletes wootoni* apparently is polylectic while *C. skinneri* appears to be oligolectic on papilionoid legumes (J. L. N. pers. obs.).

The foretarsal combs of *C. bumeliae* and *C. inuncantipedis* are remarkably similar to the those found on the foretarsi of the females of the west Palearctic species, *C. nasutus* Smith. *Colletes nasutus* is oligolectic on *Anchusa* (Boraginaceae) and uses its foretarsal arrays to extract pollen from the anthers included in the narrow corolla tubes (Müller 1995). Females of *C. nasutus* differ from *C. bumeliae* and *C. inuncanti-*

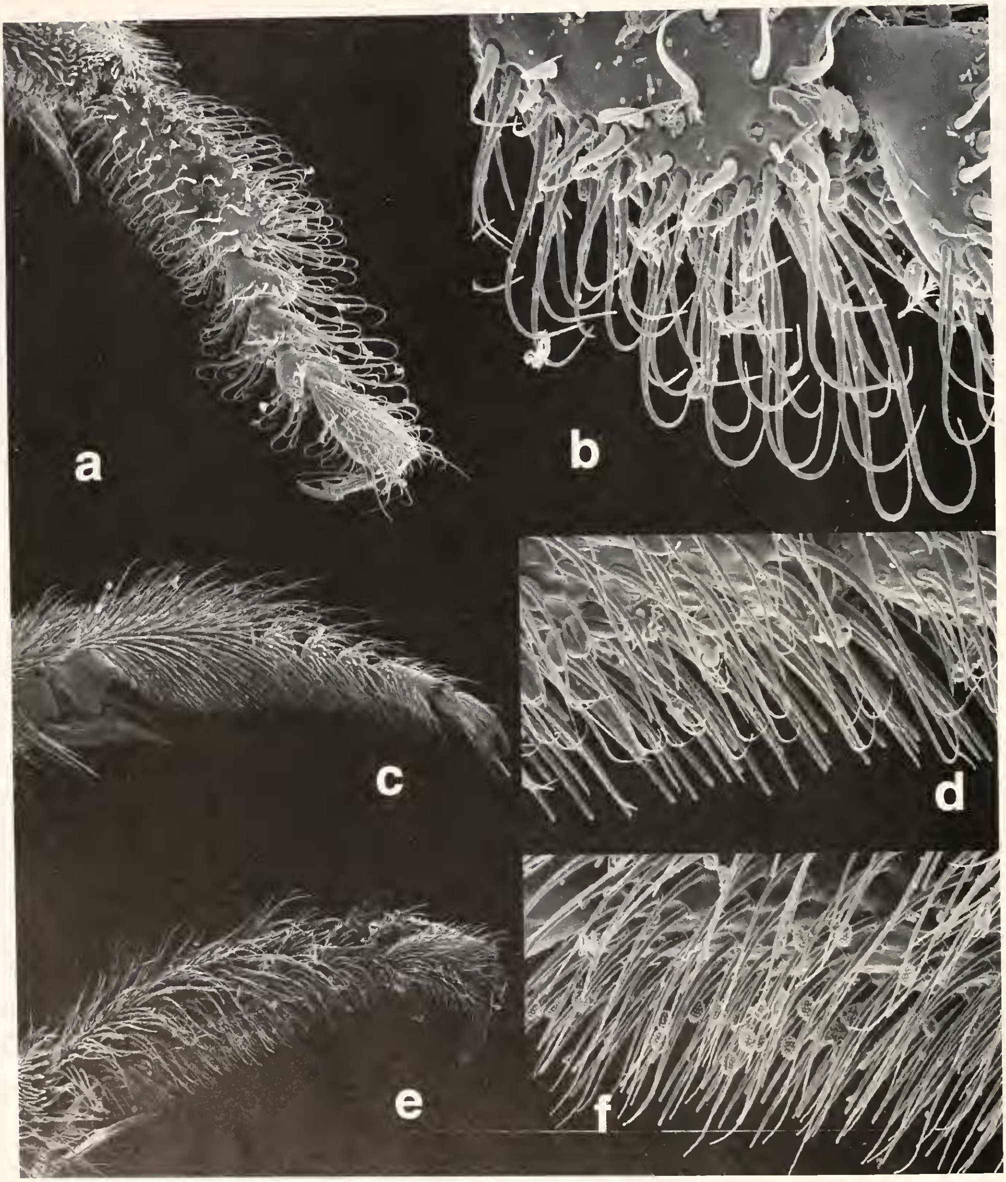

Fig. 2. Foretarsi of female *Colletes* with closeup of foretarsal setae. a, b. *Colletes inuncantipedis*. c, d. *Colletes wootoni*. e, f. *Colletes birkmanni*.

pedis in having foretarsi of normal length but elongate forefemora and -tibiae, apparently an adaptation for extracting pollen hidden in narrow corolla tubes (Müller 1995). Shortened foretarsi (and modified forefemora) are found in two closely related European *Colletes* whose foretarsi bare arrays of stout, flattened, curved setae. These two species, *C. anchusae* Noskiewiscz and *C. wolfi* Kuhlmann, are oligolectic on *Cynoglottis* (Boraginaceae) and use their tarsal setal arrays to extract pollen from the narrow floral tubes of *Cynoglottis* flowers (Müller and Kuhlmann 2003).

Müller (1995) and Müller and Kuhl-

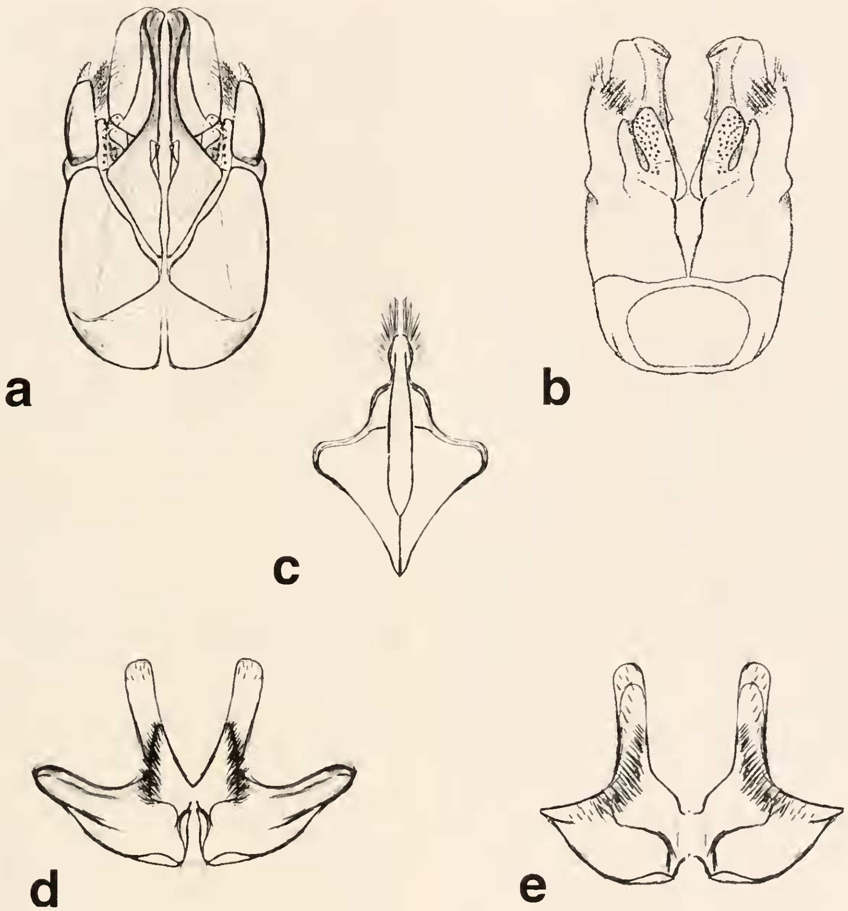

Fig. 3. Genitalia and associated sterna. a. dorsal view, genital capsule, *Colletes bumeliae*. b. ventral view, genital capsule, *C. bumeliae*. c. S8, dorsal view, *C. bumeliae*. d. S7, dorsal view, *C. bumeliae* e. S7, dorsal view, *C. inuncantipedis*.

mann (2003) used forewing length as their measure of body size, rather than head-width. Curiously, when either internal or total wing length was used in the denominator when adjusting for body size in the comparison of American bees, no significant difference was found between the tarsal lengths of females with and without hooked hairs (0.306 ± 0.007 (n = 19) vs. 0.302 ± 0.027 (n = 75), p = 0.5488 or 0.255 ± 0.008 (n = 18) vs 0.254 ± 0.022, (n = 65), P = 0.8390). However, there are several reasons why wing length may be a less than ideal estimator of body size in many bee groups. First, wing length is often compromised by wing wear. Second, wing length is expected to be an accelerating, positive function of body size due to considerations of wing loading (Danforth 1989). In addition, the use of internal markers of wing venation to avoid problems of wing wear in estimating wing length may further complicate matters since wing venation extends distally with increasing body size (Danforth 1989). Head width was more strongly correlated with transtegular distance (another measure of body size), than was wing length (R = .945 vs. R = .894) in the sample of American *Colletes*, suggesting it should be a superior estimator of body size, at least among groups like *Colletes* which lack obvious cephalic allometry. Ultimately, these estimators will need to be tested against actual body dry weight.

Nests of *C. inuncantipedis* are unknown but nests of *C. bumeliae* were discovered in deep sandy soils near Sayersville, Bastrop Co., Texas, as well as in sandy alluvial deposits along the Pedernales River at Pedernales Falls State Park, Blanco Co., Texas. Nests near Sayersville were loosely grouped along a heavily shaded, unpaved road through a post oak woodland. At Pedernales Falls, nests were scattered along a road cut through the alluvial deposits with one group of 5–7 nests clustered within the entrance of a large, abandoned mammal (armadillo?) burrow. Two nests were excavated, one each at Pedernales Falls and one at Sayersville, both with similar structure. The excavated nest at Sayersville, and other nearby nests, were on level ground and had a simple fan like tumulus formed of soil pushed away from the entrance. Entrances to the nests at Pedernales Falls were in a near vertical bank and thus lacked tumuli. The first 15–20 cm of the main burrows descended gradually to a depth of 5–10 cm before descending almost vertically. Both nests were lost before reaching any cells, the Sayersville nest at 40 cm and the Pedernales Falls nest at 28 cm. In both cases, the problem was backfilled laterals. Burrows were unlined and had an interior diameter of 5.0–5.5 mm. In both cases, the burrows each had several soil septa, each 5–10 mm thick. No cells were recovered at Sayersville but eight single cells were recovered from the Pedernales Falls excavation at depths of 30–50 cm. All cells were horizontally oriented and from 10 to 15 cm from the estimated location of the main burrow. Individual cells were of the classic membranous sandwich bag type with a folding closure (Torchio et al. 1988). One cell recovered intact was 11 mm long with a maximal diameter of 7 mm. Each cell had a collar, roughly 5 mm in diameter, which extended 3 mm from the cell entrance. Pollen in the semi-liquid provisions was 100% *Sideroxylon*.

Most pollen foraging occurs between 0900 and 1400 CDST, with some foraging as late as 1630 hrs. Full daily provisioning series for three females indicated they made 11–12 pollen trips per day. Mean pollen trip duration was 19.3 ± 6.7 min (n = 73, 9–38). Time in the nest between pollen trips averaged 4.9 ± 2.5 min (n = 72, 2–21).

Since *C. bumeliae* and *C. inuncantipedis* are often locally abundant and contact with the anthers and stigma of *S. lanuginosum* by both males and females is unavoidable during foraging, these bees potentially are important pollinators of *S. lanuginosum*. However, as they are small bees visiting a large tree, actual pollinator efficacy needs to be demonstrated directly, or at least inferred from degree of pollen carryover and frequency of interplant moves in order to have any confidence in statements on its importance as a pollinator. The overall importance of these bees in the reproductive biology of *S. lanuginosum* is probably not great since they appear to be much more restricted in distribution than the tree. Even in central Texas, the most common visitors of gum bumelia are often various wasps, particularly the fast flying males of *Myzinum* spp. (Tiphiidae), as well as males of various halictid and megachilid bee species, rather than *C. bumeliae* or *C. inuncantipedis*.

Colletes bumeliae and *C. inuncantipedis* are currently known from only five sites in three counties in central Texas. Although their ranges overlap, they have not been found together at the same site. In all cases, the sites had both *S. lanuginosum* and some nearby areas of sandy soils. The ranges of these two species are likely to expand with further collecting since the fauna of *Sideroxylon* flowers is very poorly known. Despite the wide distribution of the genus, there are no records of any hymenopterous visitors to either *Sideroxylon* or *Bumelia* in the *Hymenoptera Catalog* (Krombein et al. 1979).

ACKNOWLEDGMENTS

I thank Beryl Simpson for improving the manuscript and many other things; the Texas Parks and Wildlife Department for permission for studies at Pedernales Falls State Park; Larry Gilbert for permission for studies at BFL, Austin, Texas; Terry Griswold for a useful reference and other correspondence; John Mendenhall for assistance with SEM; John Abbott and Al Hook for the loan of material from the Entomology Collection at BFL; Rob Brooks for access to specimens at SEMC; and Ed Riley for access to material at TAMU. Michael Engel and an anonymous reviewer found many glitches in the original manuscript.

LITERATURE CITED

Anderberg, A. A., and U. Swenson. 2003. Evolutionary lineages in Sapotaceae (Ericales): A cladistic analysis based on *ndh*F sequence data. *International Journal of Plant Sciences* 164: 763–773.

Cheatham, S., M. C. Johnston, and L. Marshall. 2000. *The Useful Wild Plants of Texas, the Southeastern United States, the Southern Plains, and Northern Mexico. Volume 2.* Useful Wild Plants, Inc.; Austin, Texas; xxiii + 599 pp.

Danforth, B. N. 1989. The evolution of hymenopteran wings: The importance of size. *Journal of Zoology, London* 218: 247–276.

Griswold, T., F. D. Parker and P. E. Hanson. 1995. The bees (Apidae). Pp. 650–691. *In*: P. E. Hanson and I. D. Gauld, eds. *The Hymenoptera of Costa Rica.* Oxford University Press, Oxford, England.

Krombein, K. V., P. D. Hurd, Jr. and D. R. Smith. 1979. *Catalog of Hymenoptera in America North of Mexico.* Smithsonian Institution Press. Washington, D.C. xxx + 2735 pp.

Kuhlmann, M. 2003. Checklist of the Old World Species of the Bee Genus *Colletes* Latr. www.uni-muensterde/Landschaftsoekologie/Institut/Mitarbeiter/Kuhlmann/Coll-check/Index.htm

Mader, D. 1999. *Geologische und biologische Entomoökologie der rezenten Seidenbiene Colletes: Band I.* Logabook; Köln, Germany. xliii + 807 pp.

Michener, C. D. 2000. *The Bees of the World.* The Johns Hopkins University Press, Baltimore. Maryland; xiv + 913 pp.

Michener, C. D., R. J. McGinley, and B. N. Danforth. 1994. *The Bee Genera of North and Central America (Hymenoptera: Apoidea).* Smithsonian Institution Press, Washington, D.C. viii + 209 pp.

Moldenke, A. R. 1979. Host-plant coevolution and the diversity of bees in relation to the flora of North America. *Phytologia* 43: 357–419.

Müller, A. 1995. Morphological specializations in Central European bees for the uptake of pollen from flowers with anthers hidden in narrow corolla tubes (Hymenoptera: Apoidea). *Entomologia Generalis* 20: 43–57.

Müller, A., and M. Kuhlmann. 2003. Narrow flower specialization in two European bee species of the genus *Colletes* (Hymenoptera: Colletidae). *European Journal of Entomology* 100: 631–635.

Pennington, T. D. 1990. Sapotaceae. *Flora Neotropica* 52: 1–771.

Shinn, A. F. 1967. A revision of the bee genus *Calliopsis* and the biology and ecology of *C. andreniformis* (Hymenoptera, Andrenidae). *University of Kansas Science Bulletin* 46: 753–936.

Stephen, W. P. 1954. A revision of the bee genus *Colletes* in America north of Mexico (Hymenoptera: Colletidae). *University of Kansas Science Bulletin.* 36: 149–527.

Thorp, R. W. 1979. Structural, behavioral and physiological adaptations of bees (Apoidea) for collecting pollen. *Annals of the Missouri Botanical Garden* 66: 788–812.

Torchio, P. F., G. E. Trostle and D. J. Burdick. 1988. The nesting biology of *Colletes kincaidii* Cockerell (Hymenoptera: Colletidae) and development of its immature forms. *Annals of the Entomological Society of America* 81: 605–625.